

VUSE, VU Science Experiments and laboratory at IGLUNA, a human Moon-Ice habitat simulation.

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Introduction: The possibility of building a (semi)permanent human habitat on the Moon opens up new opportunities for the science community. A human habitat with a laboratory eliminates sample return to Earth and enables in situ analysis of samples. In a moon-ice simulation on glacier named IGLUNA [1], a group of 15 students from the VU Amsterdam demonstrate the possibilities when building a laboratory on the moon, and using a moon base for scientific purposes. This group, called VU Science Experiments (VUSE) [2] deploys a science module consisting of glaciological, geological, astrobiological and life science experiments together with a module to support analog EVA simulations. During a campaign in June-July 2019, the VUSE team demonstrates together with 19 other student teams their product. The research done by VUSE can contribute to discovering the ideal laboratory on the moon, especially if the moon base will be built around the lunar South Pole. VUSE is building forth on work and experience from previous ILEWG EuroMoonMars groups [3].

VUSE at IGLUNA simulation campaign: VUSE is one of the 20 teams that is participating in IGLUNA. IGLUNA is an ESA_Lab designed project and organized by the Swiss Space Center [4]. During a 17 day campaign in June 2019, all teams will exhibit their project at the habitat in the Klein Matterhorn glacier in Zermatt, Switzerland. VUSE's tasks in this project is showcasing the possibilities of science experiments when having an lunar ice habitat. VUSE is an independent team, consisting of 15 VU Amsterdam geology and biology students, supported by ILEWG and VU Amsterdam. The team is part of EuroMoonMars [3], which supports and participates in several simulation missions, workshops and conferences. We share our passion of space with students from VU Amsterdam and try to involve everyone with our projects.

Ice sample laboratory on the moon: The analysis of ice requires a different approach on designing a laboratory. At IGLUNA the team will focus on analyzing ice cores and small samples taken by EVA simulations. To uncover the history of the glacier where the base will be built, a researcher specialized in glaciology will analyze the deformation in ice crystals by making thin sections out of samples and observing them with a polarized microscope [5]. To prepare, observe, and analyze ice samples, a laboratory with subzero climate conditions is required. This temperature raises problems for other experiments and working condi-

tions for the astronauts working at this laboratory. When designing a laboratory at the lunar South-Pole, the ice lab needs to be integrated into the design, while the temperature of the lab is at normal working temperatures.

Scientific Goals and systems at IGLUNA: During the field campaign, the VUSE team will perform four major research goals. Our team focusses on glaciology experiments, that consist of a combination of crystal deformation analysis and chemical ice analysis to uncover the recent history of the glacier [5]. The ice samples will be shared with another research project, set to analyze micro-biotal life in ice samples using a portable mini-DNA-sequencer [6]. Using the cold environment, another part of our team focuses on growing plants with minimal additional heat [7]. Furthermore, our team prepares and performs EVA sample missions using a ground control center equipped with camera [8], telescope vision of the glacier, and direct communication between the glacier and remote support at the VU Amsterdam. All data will be stored in separate data systems [9], which will be controlled by the remote support team.

Glacier EVA simulations: Performing simulations in glacial/ice environments requires a different approach to preparing EVA's. During the campaign VUSE will use a combination of drones [10], cameras, and telescopes to make the first observations of the area around the lander situated on top of the glacier. This lander controls all cameras and telescopes. Using the footage from the drones and cameras, ground control will prepare an EVA for 1 or 2 analogue astronauts to collect samples. During the EVA both ground control and remote support will have live communication and video footage to support the team.

References:[1]<https://www.spacecenter.ch/igluna/>, [2] de Winter, B (2019) LPSC50, abstract #1588, [3] Foing, B.H (2019) LPSC50, abstract #3090 [4] Heemskerk, M.V (2019) LPSC50, abstract #2416 [5] Albers, B (2019) LPSC50 abstract #1336 [6] Clement, T (2019) LPSC50, abstract #2445, [7] van Bloois, S (2019) LPSC50, abstract #2415, [8] Berg, M.J.R (2019) abstract #2687, [9] Kruijver, A (2019) LPSC50, abstract #2869, [10] Korthouwer, R.B (2019) LPSC50, abstract #2475